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THE REFRACTIVE CHARACTERISTICS
AND
INTRAOCULAR TENSIONS OF COLONY CHIMPANZEES

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FOREWORD

This report is based on a study at the 6571st Aeromedical Research Laboratory with Dr. Francis A. Young as a consultant from Washington State University Primate Research Center. Grateful acknowledgment is extended to Mr. Scott Oakley for his technical assistance in the data collection, and to Dr. Kenneth Oakley for his assistance in refracting the chimpanzee eyes. The work was accomplished during August 1965 under Project 6893, Task 689302.

* * * *

This technical report has been reviewed and is approved.



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ABSTRACT

Ninety-six chimpanzees, 54 males and 42 females, ranging in age from less than 3 years to 15 years, were refracted in both supine and sitting positions under Sernylan (proprietary preparation of the Parke-Davis Company) anesthesia and Cyclogyl (proprietary preparation of the Schieffelin Company) cycloplegia. Intraocular pressures were obtained under the same conditions. High reliability ($r = + .930$ overall) between refractions and the tendency toward increasing minus refractive error as a function of age was confirmed.

INTRODUCTION

Polyak (Ref. 1, 2) and Kolmer (Ref. 3) studied the chimpanzee eye anatomically and reported that there is a close similarity between human and chimpanzee eyes. These early research efforts implied functional similarities but, until recently, very little was known about the refractive characteristics and intraocular tensions of chimpanzee eyes.

In three previous studies (Ref. 4, 5, 6) efforts were made to obtain normative data for a colony of chimpanzees. In the first study (Ref. 4) data were obtained from 43 chimpanzees (26 males and 17 females) ranging in age from 2 to 8 years. In the second study (Ref. 5) data were obtained on 50 chimpanzees (29 males and 21 females) ranging in age from 2 to 9 years, and in the third study (Ref. 6), 60 chimpanzees (34 males and 26 females) were tested in the age range 3 to 10 years. These data were obtained from animals with a cycloplegic in the supine position and under a general anesthetic¹. From these three prior efforts, it was concluded that normal values and responses to the experimental conditions are very similar in men and chimpanzees. The increase in minus refractive error after 12 months ($N = 36$) and after 24 months ($N = 19$) obtained by the test-retest technique was expected on the basis of Hirsch's (Ref. 7) hypothesis resulting from his work with children 5 to 14 years old. Also, the increase in minus refractive error in older animals confirmed his findings in children.

The longitudinal analysis of the intraocular tension demonstrated an increase as a function of time. The data (Ref. 6) indicated a strong relationship between intraocular tension increase and myopic progressions as confirmed by correlation coefficients.

¹ Pentothal sodium was used as the anesthetic for the first study (Ref. 4) and phenylcyclidine hydrochloride (Sernylan) was used as the anesthetic in the subsequent studies. This experimental drug was made available by Parke-Davis and Company. Cyclopentolate hydrochloride (Cyclogyl) was used in all cases as the cycloplegic.

The purpose of the present study was to gain additional information about the progression of myopia in young chimpanzees as a function of age. The refractive characteristics and intra-ocular tensions were determined for each eye of the available population of chimpanzees by two independent retinoscopic examiners.

II

METHOD

A. Subjects

The animals used in this study comprised 96 available chimpanzees (54 males and 42 females) from the total population of 119 animals at the colony of Holloman Air Force Base. The subjects are listed according to age, based on dental eruptions, and sex as shown in Table I.

Table I. Age and Sex Determination of the Subjects

<u>Age (Years)</u>	<u>Males (Numbers)</u>	<u>Females (Numbers)</u>	<u>Total (Numbers)</u>
2	5	2	7
3	8	7	15
4	6	3	9
5	12	9	21
6	8	8	16
7	8	4	12
8	4	2	6
9	1	1	2
10	2	2	4
11	0	2	2
12	0	1	1
15	<u>0</u>	<u>1</u>	<u>1</u>
Total N =	54	42	96

B. Procedure

On the day of the refraction, the chimpanzees were not fed until the examination had been completed. Small chimpanzees (less than 50 pounds) were brought into the examining room and strapped to a portable operating table, and one drop of 1 percent cyclopentolate hydrochloride (Cyclogyl) was placed in each conjunctival sac. Ten minutes later, a second drop was administered. Following the second drop, the chimpanzees were given 0.75 mg. Sernylan per pound body weight, intramuscularly. Twenty minutes later, a third drop of Cyclogyl was placed in each conjunctival sac,

Forty-five minutes after the initial administration of Cyclogyl the subject was refracted in a sitting position with a Copeland Streak Retinoscope and a trial lens set. Immediately following this refraction, the subject was placed in the supine position and the refraction was independently determined by another refractionist. Neither refractionist had knowledge of the other refractionist's findings until both determinations were completed. Following the second refraction, the intraocular tension was determined with a Schiottz tonometer. The subject was removed to a recovery room following this last determination. The procedure for large chimpanzees (above 50 pounds) was the same as used on the smaller animals, except Sernylan was administered before the large animal was removed from the housing cage. Thus, the larger animals received all administrations of Cyclogyl following Sernylan. The refractions were determined in the same manner and, after the intraocular tensions were obtained, the large animals were returned to their housing cages.

C. Apparatus

All examinations were accomplished in a veterinary treatment room with a Copeland Streak Retinoscope, American Optical trial lens set, Schiottz tonometer, a small animal operating table, and a primate restraint chair.

III

RESULTS

A. Longitudinal Comparisons

1. Thirty-six month interval.

Using a test-retest design for the data obtained from the 27 chimpanzees which were first refracted (by the same refractionist) 36 months prior to the retest date, it was discovered that there was a statistically significant increase in myopia for each eye (OD² t test = 2.83 $P < .01$, and OS³ t test = 3.05 $P < .01$) as well as for combined eyes (combined t = $P < .01$). Two-tailed tests of significance were employed.

No evidence for corresponding increases in intra-ocular pressures were found with the OD, OS and combined eyes t tests (OD t < 1.00, OS t = 1.34, combined eyes t < 1.00) -- two-tailed tests of significance.

2. Twenty-four month interval.

Using the same test-retest procedures for the data obtained from the 43 chimpanzees which were first refracted (by the same refractionist) 24 months prior to the retest date, it was discovered that the combined eyes and OS t values reflected scores which were significantly more myopic at the .01 confidence level, and the OD values indicated change in the direction of increased myopia ($P > .05$).

These refractive error data were supported with statistically significant intraocular tension changes also (OD t = 6.88 $P < .01$, OS t = 5.37 $P < .01$, combined eyes t = 7.95 $P < .01$). The OD, OS and combined eyes t tests reflected changes at the .05 level of confidence.

3. Twelve-month interval.

The test-retest procedures for the data obtained from the 55 chimpanzees which were first refracted (by the same refractionist) 12 months prior to the retest date yielded results

² OD = Oculus Dexter

³ OS = Oculus Sinister

consistent with the longer test intervals (OD $t = 1.00$ $P > .05$, OS $t = 1.11$ $P > .05$, combined eyes $t = 2.00$ $P < .05$). The changes in the refractive error were toward increasing myopia. The intraocular tension comparisons changed significantly during the 12 month test-retest interval, also. (OD $t = 1.65$ $P < .05$, OS $t = 11.00$ $P < .01$, combined eyes $t = 15.38$ $P < .01$). However, these OD and OS tension values were below the values required for statistical significance, and only the combined eyes ($N = 110$) data exceeded the required $P < .05$ value.

B. Transverse Comparisons

The mean refractive errors and mean intraocular pressures for each eye by age group, sex, combined sex, OD and OS and combined eyes for the 96 chimpanzees examined in this study are presented in Table II. The standard deviations for these data are presented in Table III, and the medians for these data are shown in Table IV. By visual inspection, some data are skewed, but the refractive status information appears to show increases in minus error as a function of age, but OD - OS comparisons as well as sex comparisons do not reflect significant trends. The age x eye x sex analysis of variance supported these observations. The main effect, age, was statistically significant at the .01 level of confidence, but no other treatment effect reached significance at the .05 level or higher.

The data on the intraocular tensions do not appear to indicate any trends as a function of age, eyes or sex. Individual subject variability is quite large as indicated by the standard deviation tables, and age, eye and sex variability appears to be less than the intragroup variable. The age x eye x sex analysis of variance supported these observations, as none of the three main effects nor the four interaction effects were statistically significant (alpha level = .05, two-tailed test).

C. Refractionist Comparisons

The refractive errors obtained by one refractionist in the supine position were compared to the data obtained in the sitting position by the second refractionist. The overall correlation coefficient was $+ .930$. The OS correlation was $+ .940$, and the OD correlation was $+ .804$. These correlations are statistically significant beyond the .01 level of confidence, two-tailed test.

TABLE II Mean Refractive Error (Diopters) and Intraocular Pressure (mm Hg) by Age, Eye, Sex, and Combined

Group Age	3	3	4	5	6	7	8	9	10	11	12	15	Total	OD+OS
Females (No.)	2	7	3	9	8	4	2	1	2	2	1	1	42	84
OD (error)	1.62	0.02	1.00	-0.71	-0.67	-1.38	-1.25	-1.25	-4.69	-6.38	-3.50	-0.75	-0.98	-0.99
OS (error)	0.94	-0.04	0.96	-1.03	-0.25	-1.13	-0.75	-1.75	-5.57	-6.50	-3.25	-0.25	-1.00	
OD (Pressure)	10.56	10.11	8.90	9.56	7.91	9.66	8.76	7.32	9.15	7.74	11.34	12.36	9.26	9.33
OS (Pressure)	9.84	7.67	11.70	9.27	8.81	10.79	9.15	8.76	9.21	10.38	10.38	12.36	9.39	
Males (No.)	5	9	6	112	8	8	4	1	2	-	-	-	55	110
OD (error)	0.67	0.23	-0.38	-0.80	-0.98	-1.94	-0.88	-2.50	-0.31	-	-	-	-0.66	-0.77
OS (error)	0.72	0.24	-0.50	-1.02	-1.92	-1.94	-0.94	-2.25	-0.63	-	-	-	-0.87	
OD (Pressure)	10.38	10.37	8.55	9.99	10.51	9.96	8.95	10.38	10.95	-	-	-	10.51	10.06
OS (Pressure)	9.70	10.39	9.35	8.93	9.56	9.58	9.41	10.38	10.95	-	-	-	9.61	
Combined (No.)	7	16	9	21	16	12	6	2	4	-	-	-	93	186
OD (error)	0.94	0.14	0.08	-0.76	-0.83	-1.75	-1.00	-1.03	-2.50	-	-	-	-0.65	-0.72
OS (error)	0.78	0.12	-0.01	-1.02	-1.09	-1.67	-0.88	-2.00	-3.10	-	-	-	-0.79	
OD (Pressure)	10.43	10.26	8.67	9.81	9.21	9.86	8.89	8.85	10.05	-	-	-	9.66	9.56
OS (Pressure)	9.74	9.20	10.14	9.08	9.19	9.98	9.32	9.57	10.08	-	-	-	9.46	
OD+OS (No.)	14	32	18	42	32	24	12	4	8	-	-	-	186	
Error	0.86	1.13	0.04	-0.89	-0.96	-1.71	-0.94	-1.94	-2.80	-	-	-	-0.72	
Pressure	10.09	9.70	9.41	9.45	9.20	9.90	9.41	9.21	10.07	-	-	-	9.56	

TABLE III Standard Deviations

Group Age	3	3	4	5	6	7	8	9	10	11	12	15	Total	OD+OS
Females (No.)	2	7	3	9	8	4	2	1	2	2	1	1	42	84
OD (error)	0.36	0.52	1.09	1.95	1.45	1.13	1.06	0.00	6.10	5.13	0.00	0.00	1.69	1.83
OS (error)	0.10	0.95	0.97	2.16	1.75	1.27	1.77	0.00	8.04	4.95	0.00	0.00	1.99	
OD (Pressure)	2.55	1.50	2.14	1.65	1.79	1.80	0.00	0.00	0.55	3.73	0.00	0.00	1.54	1.85
OS (Pressure)	3.56	4.02	1.14	2.11	1.89	2.05	0.55	0.00	1.66	0.00	0.00	0.00	2.15	
Males (No.)	5	9	6	12	8	8	4	1	2	-	-	-	55	110
OD (error)	1.08	0.81	1.93	1.53	1.73	2.55	0.33	0.00	1.14	-	-	-	1.51	1.63
OS (error)	0.83	0.72	1.84	1.61	2.85	2.92	0.75	0.00	0.17	-	-	-	1.77	
OD (Pressure)	2.00	1.31	1.04	1.98	1.63	2.79	0.39	0.00	1.99	-	-	-	1.70	1.68
OS (Pressure)	2.63	1.44	2.27	1.63	1.71	1.84	1.45	0.00	1.99	-	-	-	1.69	
Combined (No.)	7	16	9	21	16	12	6	2	4	-	-	-	93	186
OD (error)	0.89	0.68	1.62	1.68	1.54	2.12	0.54	0.00	3.58	-	-	-	1.52	1.68
OS (error)	0.68	0.80	1.53	1.81	2.28	2.42	0.98	0.00	4.64	-	-	-	1.83	
OD (Pressure)	1.93	1.35	1.35	1.80	1.66	2.41	0.30	0.00	1.19	-	-	-	1.61	1.77
OS (Pressure)	2.59	1.05	1.88	1.80	1.74	1.82	1.14	0.00	1.50	-	-	-	1.93	
OD+OS (No.)	14	32	18	42	32	24	12	4	8	-	-	-	186	
Error	0.76	0.73	1.53	1.72	1.92	2.22	0.75	0.00	3.84	-	-	-	1.68	
Pressure	2.20	2.13	1.59	1.78	1.67	2.09	0.80	0.00	1.25	-	-	-	1.77	

TABLE IV Median Refractive Error (Diopters) and Intraocular Pressure (mm Hg) by Age, Eye, Sex, and Combined

Group Age	3	3	4	5	6	7	8	9	10	11	12	15	Total	OD+OS
Females (No.)	2	7	3	9	8	4	2	1	2	2	1	1	42	84
OD (error)	1.62	0.25	1.50	0.00	-0.19	-1.38	-1.25	-1.25	-4.69	-6.38	-3.50	-0.75	-	-
OS (error)	0.94	0.25	1.25	-0.75	-0.75	-0.88	-0.75	-1.75	-5.57	-6.50	-3.25	-0.25	-	-
OD (Pressure)	10.56	10.38	8.04	10.38	7.32	8.76	8.76	7.32	9.15	7.74	11.34	12.36	8.76	9.54
OS (Pressure)	9.84	9.54	12.36	9.57	8.76	11.37	9.15	8.76	9.21	10.38	10.38	12.36	9.96	
Males (No.)	5	9	6	12	8	8	4	1	2	-	-	-	55	110
OD (error)	0.75	0.25	0.12	-0.56	-0.69	-1.33	-0.88	-2.50	-0.32	-	-	-	-	-
OS (error)	1.12	0.25	0.25	-0.63	-1.25	-0.94	-1.00	-2.25	-0.63	-	-	-	-	-
OD (Pressure)	10.38	10.38	8.40	9.57	10.38	9.57	8.76	10.38	10.95	-	-	-	10.38	10.38
OS (Pressure)	10.38	10.38	9.96	8.76	9.96	9.57	9.96	10.38	10.95	-	-	-	10.38	
Combined (No.)	7	16	9	21	16	12	6	2	4	-	-	-	93	186
OD (error)	1.25	0.25	0.50	-0.50	-0.45	-1.38	-0.88	-1.88	-0.75	-	-	-	-	-
OS (error)	1.12	0.25	0.50	-0.75	-1.13	-0.94	-1.50	-2.00	-0.63	-	-	-	-	-
OD (Pressure)	10.38	10.38	8.04	10.38	9.96	8.76	8.76	8.85	9.54	-	-	-	9.54	9.54
OS (Pressure)	10.38	10.38	10.38	8.76	8.76	10.38	9.54	9.57	9.91	-	-	-	9.54	
OD+OS (No.)	14	32	18	42	32	24	12	4	8	-	-	-	186	
Error	1.06	.25	.50	-.69	-.75	-1.12	-.87	-2.00	-.63	-	-	-	-	-
Pressure	10.38	10.38	9.15	8.76	9.15	9.57	8.76	9.57	9.54	-	-	-	9.54	

IV

DISCUSSION

The increasing minus refractive error found in the longitudinal analyses support the generally accepted notions that a shift toward emmetropia and myopia is associated with increasing chronological age. The negatively associated trend postulated on the basis of the earlier chimpanzee study (Ref. 6) was supported in the present study. Statistical significance was established for the 36-month data, and the 24-month data, but the 12-month test-retest values failed to reach the required .05 level of confidence. The transverse analyses support the longitudinal analyses with significance attributable to greater minus refractive error attributable to older colony animals.

The intraocular tensions reflected considerable variability within individual subjects. The trends toward increasing pressures found in the previous research were not confirmed by these data. The three-year comparisons showed no statistically significant changes, but both the two-year values and the one-year values decreased significantly.

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14. KEY WORDS	LINK A		LINK B		LINK C	
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Eyes						
Myopia						
Sitting position						
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